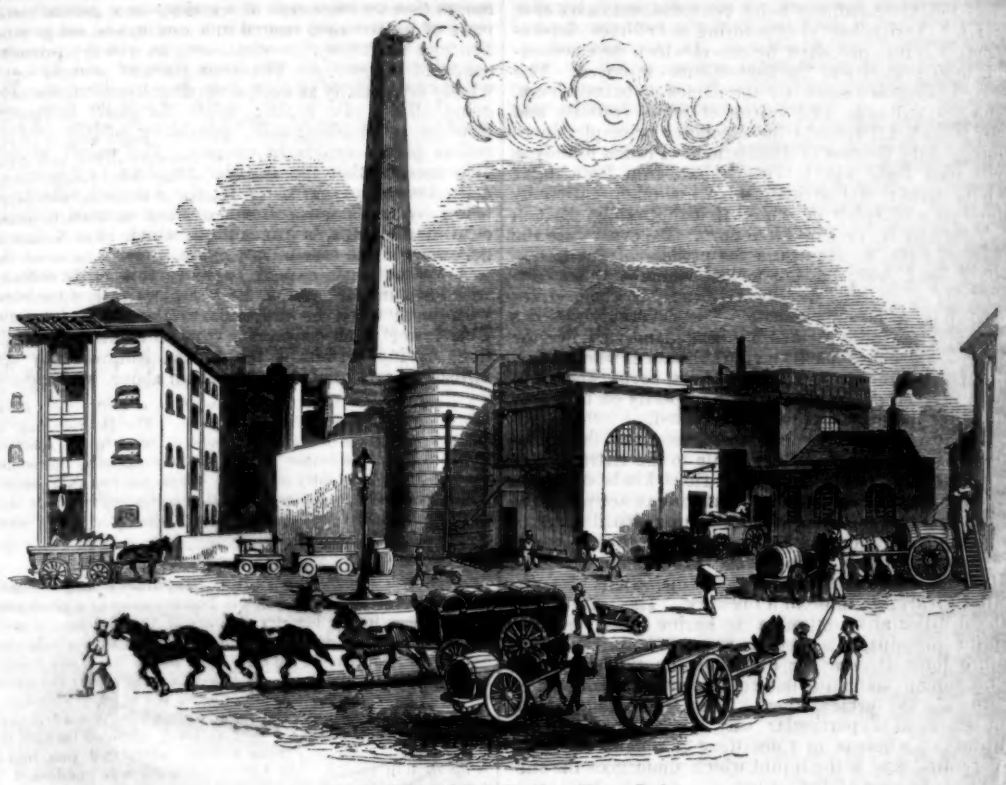
A DAY AT A DISTILLERY.



Messrs. Smith and Co.'s Distillery, Thames Bank.

THE subject of the present Supplement takes us up the river to the vicinity of Chelsea. Let us, then, get on board one of the little river-steamers, and proceed in that direction.

After passing Vauxhall Bridge, we stop for a few moments—as everybody now knows—at the Nine-Elms pier, and thence proceed onward towards the termination of the route at Chelsea. On the left we pass the South London Water-works, as well as factories, warehouses, and wharfs of different kinds; and then arrive at the river-side house so well known to all amateur boatmen as the 'Red House.' On the right, after passing a gas-factory, we see the noble manufacturing premises of Messrs. Cubitt, the builders, with the chimney inclosed in a decorated square tower. Then we come to the London Steel-works; beyond which is the Belgrave Dock; and westward of both are two tall chimneys, one of which points out the Chelsea Water-works, and the other the distillery of Messrs. Octavius Smith and Co., the establishment to which our attention is here directed. This latter-named chimney is conspicuous from the river on account of its proportions; the celebrated obelisk called 'Cleopatra's Needle' having been taken as a model in its construction. The river-front of this factory presents to view a dock, whereinto barges laden with corn and coals for the factory are conveyed to be unladen.

The entrance to the distillery is on the eastern side, and on entering the outer gates we find ourselves in an irregularly-shaped open court, surrounded by buildings, of which several are seen in the frontispiece. On the left are large granaries, where the grain, after being hoisted from barges in the dock, is stored. Beyond these we see various buildings connected with the still-room, comprising a cylindrical worm-tub of very large dimensions, water-tanks and cooling-tanks at a considerable elevation, store-warehouses, &c. In front are the offices and counting-houses; bounded on the right by various workshops for smiths, millwrights, coppersmiths, carpenters, and others engaged in the repair and adjustment of the apparatus used in the distillery. On the right of the entrance, and extending to a considerable distance northward, are the mill and the brewhouse, wherein all those operations are conducted which precede the actual distillation. Stables and other outhouses occupy other parts of the area; while the open court presents a busy scene of traffic: here waggons being laden with casks about to leave the distillery; at another spot yeast being brought in from the great London breweries; at a third, 'grains' being carted for conveyance to the dairies; and at a fourth, men filling barrels with 'spent-wash,' to be carried away as a fattening ingredient for cattle and pigs.

Before describing the operations of this establishment, which we have been permitted to do by the liberality of the proprietors, it may be well to explain briefly what is meant by the terms 'distillation' and 'distillery.' All kinds of grain, such as wheat, rye,

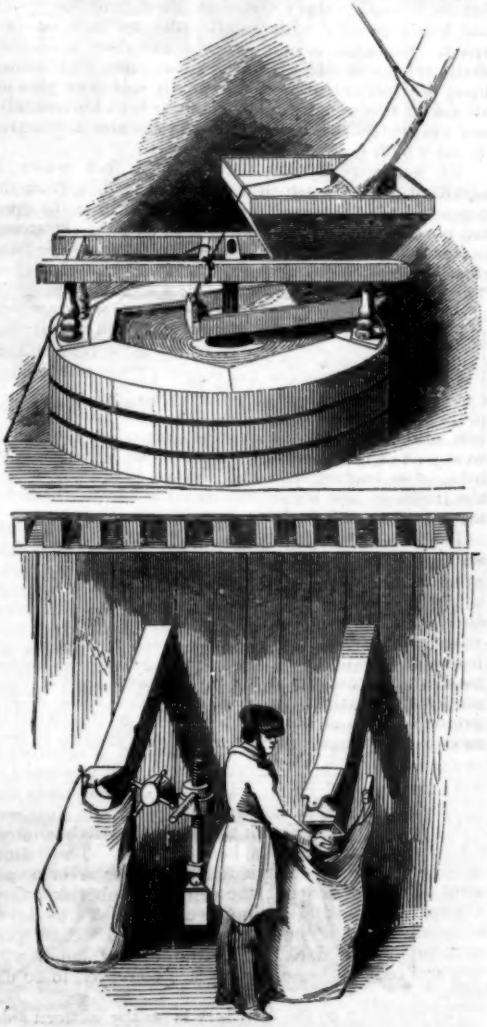
barley, oats, &c., whether in the raw or the malted state, as well as the juices of fruits, of the sugar-cane, of potatoes, of beet-root, and of many other vegetable substances, contain certain elements which, by peculiar processes, are capable of being converted into *alcohol* or *spirit*. Distillation always forms one of these operations; but it is preceded by others which vary according to the nature of the ingredients employed. The various liquids known by the names of brandy, rum, whiskey, hollands, gin, spirits of wine, cordials, and compounds, all contain the alcoholic principle, developed by the process of distillation. French brandy is produced from wine; West Indian rum from sugar or molasses; and British spirit, whether called by the name of spirit of wine, British brandy, British rum, whiskey, or gin, from corn. In every case the substance which undergoes the process of distillation is a *sweet* liquid; but the means whereby this sweetness or saccharine quality is brought about differ according to circumstances. The different qualities presented by these various liquids depend partly on the alcoholic strength, partly on the substances whence they are produced, partly on the berries, herbs, and seeds with which they are flavoured, and partly on the mode in which the manufacture is conducted.

We are prepared to understand, then, that the operations of a British distillery relate to the extraction of the alcoholic principle from various kinds of grain. We must next bear in mind, that the extract produced from this grain is *brewed* before being distilled: it is in fact converted into a kind of beer before that change is induced which leads to the production of spirit. Hence it follows that many of the operations of a distillery resemble those of a brewery. The brewer and the distiller alike extract a saccharine substance from grain (principally *malted* in respect to brewing, but more generally *raw* for distilling), by the process of 'mashing;' and alike subject this sweet liquid, called 'worts,' to fermentation. The fermented liquor, modified in a particular way, forms 'beer' at the brewery; whereas in a distillery it obtains the name of 'wash,' and is the liquid which undergoes the subsequent process of distillation.

The staple ingredient, then, at the distillery, is grain, and this is brought into the establishment to which our attention will be now directed in barges belonging to the firm. These barges are laden from the vessels which bring the grain from various ports, the grain being brought in sacks containing four bushels each. The dock is contrived so judiciously that the barges can float in at high-water, and pass immediately under the granary, into which the sacks are hoisted from the barge by means of tackle of the usual kind. The granary is a large brick building, having three extensive floors, on which the grain is stored. Malt is barley which has undergone, on the premises of the maltster, a process calculated to render it more fitted for the purposes of the brewer than barley or other grain in the raw or unmalted state; but the distiller can employ either raw or malted grain according to circumstances. Malt being much more expensive on account of the duty, than raw grain, the distiller usually employs as little of the former as the nature of the process requires. The proportion is now frequently one part of malt to ten or twelve of raw grain; the raw grain being varying mixtures of wheat, barley, rye, and oats, according to the state of the market; but more than half of the entire ingredients is generally raw barley.

On one of the granary floors we saw a heap of about two thousand quarters of kiln-dried barley, lying in a stratum five feet thick, and waiting to be conveyed to the mill. All the grain required at the distillery, about forty thousand quarters per annum, passes thus through the granary; and when about to be ground into meal, it is conveyed to a room immediately over the mill-room, and discharged through trap-doors in the floor into cloth pipes, which conduct it to the millstones. To the mill-room we next descend; where we see six pairs of mill-stones, ranged in a circle, and set in motion by a shaft from the steam-engine rising up in the centre of the group. These six pairs of stones, kept wholly or partially at work according to circumstances, grind all the raw grain; while the malt is passed through a 'crushing-mill,' consisting mainly of two rollers placed nearly in contact. The object of this difference is, that the distiller requires to *crush* the malt, instead of *grinding* it; the internal substance being by this means softened or disintegrated without cutting the husk, a precaution which is not found necessary in the case of raw grain.

A visitor must expect to leave this mill-room as white as a miller; nor is he less plentifully sprinkled with meal when he descends to the room beneath. This lower room contains a vertical cylindrical partition, having within it the mechanism whereby the millstones are rotated in the room above, and around



[Grain-mill and Meal-sacks.]

it pipes or openings, through which the ground meal descends from the mills. The mill-men fasten sacks to these openings, and thus receive the meal as it descends heated to a temperature of perhaps 100° by the friction of the stones. The preceding cut represents the general nature of the operations in both these floors of the mill: the upper division showing the operation of the millstones in the room above; and the lower showing the reception of the ground meal in the room beneath.

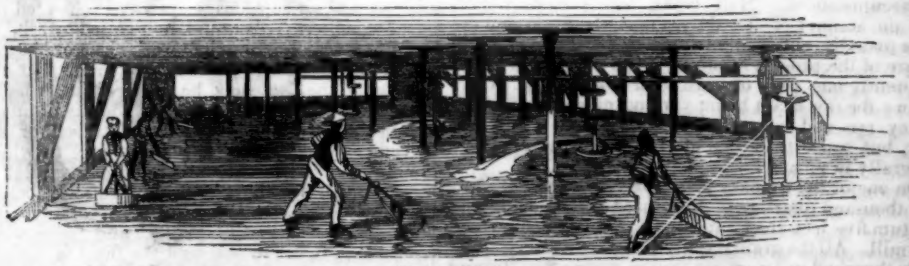
We next trace the meal, thus ground, to the brewhouse, through a gallery or covered way, leading from the south to the north department of the establishment. In this brewhouse are three large coppers, each provided with a fireplace underneath, and the whole capable of containing about fifty thousand gallons; these are for the purpose of heating the water wherewith the brewing process is effected. The most important vessels in the brewhouse are the 'mash-tuns,' two in number: these are cast-iron circular vessels, upwards of twenty feet in diameter, and each capable of containing twenty thousand gallons; each is provided with a double bottom, one above the other, having a small vacancy between them, and the upper one being pierced with small holes an inch or two apart. From the middle of each tun rises a vertical shaft, set in motion by a steam-engine, and acting upon horizontal arms, studded with spikes or pins on all sides: this apparatus, by rotating both horizontally and vertically, effectually stirs and agitates any ingredients which may be in the tun.

All being ready for the brewing, hot water is admitted to the 'mash-tuns' by pipes leading from the coppers; while ground meal is thrown in at the open top of each tun. The sacks of ground meal are stored in the mill adjoining the brewhouse, and are from thence wheeled to the tun on low hand-carriages. This is a very bustling scene when a 'mashing' is about to commence, ten or a dozen men being employed to wheel in the sacks, discharge the meal, and return for another cargo. We may here remark that the water is conveyed to the coppers from a very large cast-iron tank, or 'liquor-back,' on another part of the premises: it is pumped into this tank from a reservoir sunk below the level of the ground in the north-west part of the premises, the reservoir being supplied by a pipe leading from the Thames at a point within the limits of low-water; so that a constant supply of water is thus obtained.

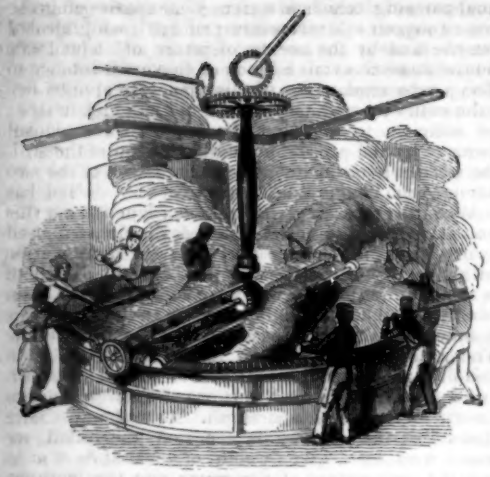
The crushed malt, the ground grain, and the hot water, being admitted into the tuns in the requisite proportions, the rotating stirrer or 'mashing-machine' is put into action, whereby the solid and liquid ingredients are so completely mixed up together, that the water is enabled to extract the saccharine elements from the meal. Men are also employed with long-handled instruments to stir the sediment, which might otherwise remain at the bottom; and a scene is then presented such as is shown in the cut at the top of the next page. These operations continue for two or three hours, during which a striking chemical change has been going on. Meal consists principally of *gluten* and *starch*; and by the agency of water and a sufficient temperature this starch becomes converted into sugar. The precise explanation of this change involves chemical niceties into which we need not enter; but it will be sufficient to say, that the water, converted into 'worts' by the process of mashing, acquires a sweet though sickly taste, arising from the starch of the meal having been converted into sugar.

When the 'mashing' has been continued to a certain extent, five or six pipes are opened, through which the 'worts' are allowed to flow into cast-iron cisterns called 'under-backs,' in a cellar beneath. The meal is retained by the upper or false bottom of the mash-tun, which thus acts as a sieve or strainer, allowing nothing but liquid to pass through the perforations. The meal does not lose all its saccharine quality by this first mashing: it is therefore 'mashed' a second and a third time, in fresh portions of water; producing 'worts' of less and less strength. As to the number of times that the mashing is repeated, the quantity of water used for a given weight of meal at each mashing, the temperature of the water, and the length of time during which the mashing is continued—these are points on which each individual manufacturer exercises his skill and judgment, and may possibly vary considerably in different establishments. When the saccharine qualities of the meal are as far as possible extracted, the residue, under the name of 'grains,' is carried out to the grain-stage, in the yard of the distillery, thence to be sold as food for cattle.

From the under-backs, the 'worts' are pumped up to the coolers or cooling-floors, occupying the upper portion of a building contiguous to the brewhouse on the north. These floors are covered or paved with cast-iron plates, three or four feet square, and joined edge to edge; raised ledges are placed across the floors at certain distances, to divide them into compartments; and into the shallow cells or trays thus formed the hot wort is introduced. The whole floor, upwards of a hundred and fifty feet in length, becomes thus covered with a stratum of hot liquor five or six inches deep; which is speedily cooled by the access of air from open windows on all sides of the coolers. This speedy cooling is necessary to prevent the acidification of the sweet wort, a result which has a tendency to follow when the cooling is too slowly effected. There are two of these cooling-floors, both paved with cast-iron plates, and both arranged in a similar manner. Such a mode of cooling is very prevalently adopted in the large breweries and distilleries; though in some cases 'refrigerators' are employed, in which the hot wort passes through pipes exposed externally to a current of cold water. It is merely a question of expediency as to which method is employed; for the principle is the same in both cases, viz., the rapid abstraction of heat by a medium colder than the wort itself. In the adjoining cut we have represented one of these floors, covered with the hot liquid, and sup-



[Cooling-floor.]



[Mash-tun.]

plied with certain pieces of apparatus whereby a current of cool air is more effectually kept up.

From the coolers the wort descends into the 'fermenting-backs,' a series of square vessels of enormous dimensions: they are sixteen in number, each about thirty feet long and half as wide, having an aggregate capacity of nearly half a million gallons. Here the liquid is exposed to the action of *yeast*, bought for that purpose of the great porter-brewers: the alcoholic fermentation ensues, whereby the sugar, which had been developed from the grain during the process of mashing, becomes converted into alcohol or spirit. This is one of the most delicate of all the operations, whether in a brewery or a distillery, requiring extensive knowledge both of the principles of chemistry and of practical results. The nature of the process may be briefly explained as follows:—The wort, in consequence of containing a considerable amount of saccharine matter in solution, is heavier than water; and the manufacturers express the degree of density by stating how many pounds heavier a barrel of wort is than a barrel of water. Whatever may be the strength of the wort actually obtained in any one mashing, the distiller is confined to certain limits when he transfers the mingled wort to the fermenting-tun; for he is obliged by law to bring the wort to a specific gravity somewhere between 1·050 and 1·090, water being 1·000. This specific gravity becomes gradually lessened in the fermenting-backs, by the gradual conversion of the sugar into alcohol; this latter-named liquid being very much lighter than water. The specific gravity is in fact brought down very near to that of distilled water, and the wort, now denominated 'wash,' may be considered as a mixture of alcohol and water, containing a small quantity of an essential oil, a little saccharine matter, and one or two other substances.

We now come to that part of the distiller's operations where it is desirable to speak of the relations between the manufacturer and the Excise. The system of supervision whereby the revenue in spirits is collected is a remarkable instance of Excise machinery; a supervision rendered important by the large revenue annually collected, and by the comparatively small number of establishments from which the payments are made. The single firm whose establishment forms the subject of our present notice pays no less a sum than 300,000*l.* a year to government in duty on the spirits manufactured; and as the duty per gallon is estimated on spirits of one particular degree of strength, the utmost caution is necessary in testing the strength of all the spirits produced, as a guarantee that all the spirit produced shall pay a duty exactly proportionate both to its quantity and its strength. As agents on the part of the government, there are excise-officers almost constantly present at every distillery, day and night. They succeed each other, one or more at a time as may be necessary, after intervals of eight hours; the periods being from six in the morning till two in the afternoon, from thence to ten at night, and from thence to six the next morning.

The act of parliament by which distilleries are now regulated was passed in 1825. By its provisions no distiller is allowed to commence operations till he has procured a licence, which licence is to be renewed annually; nor is he allowed to keep on his premises a still below a certain capacity. The number of stills, charges, receivers, &c. employed by him is also placed under certain restrictions; and the precise routine is marked out as to the mode in which the liquid shall pass from one vessel to another in the process of distillation. The number of openings in the principal vessels is expressly stated; and the most scrupulous care is taken that nothing shall pass from one vessel to another without flowing through a pipe provided with a cock or valve of which the excise-officer has the key. He is provided with keys whereby he can lock up the furnace-doors, lock up the stills, and in fact exercise a most thorough control over all the operations. In order further to facilitate the supervision of the excise-officers, the brewing and the distilling take place in alternate periods; one portion of time being appropriated to the preparation of 'wash,' or 'fermented wort,' in the brewery, and the next to distillation of spirit from the wash thus produced. On paying a visit to a distillery, therefore, we are sure to find one-half of the operations suspended, according as it may happen to be brewing-time or distilling-time. These complex arrangements arise principally out of the peculiar mode in which the duty is estimated, for not only is the spirit tested as to quantity and strength, during and after the process of distillation, but the specific gravity of the 'wort' and of the 'wash' is taken, the one heavy and the other light, and an assumption is made that a given quantity of spirit will result from a given difference in these two specific gravities. If it happens that the actual quantity of spirit, ascertained after the distillation, differs from the hypothetical quantity arising from the previous calculations of the officer, he gives to the government the "benefit of the doubt," and charges duty on the higher quantity, whichever that may happen to be. The mode in which this double mode of computation is likely to check improvements in manufacture forms a delicate subject into which we cannot here enter.

We shall now be prepared to follow a routine of processes in which the excise-officer is an important personage. We have explained that the 'wort,' or sweet liquor arising from the mashing, ferments in the fermenting-backs until its specific gravity is greatly reduced, and its saccharine quality exchanged for one more alcoholic. This liquid, now called 'wash,' is conveyed to a vessel called the 'wash-charger,' as the first step in the distilling process. In order that the intentions of the law may be carried out, which prohibit the simultaneous brewing and distilling in one establishment, the buildings are detached, or at least conveniently divided. The still-house, to which we now transfer our attention, is a large, irregular building occupied by the vessels immediately connected with the distillation; the principal of these vessels being called 'chargers,' 'stills,' and 'receivers,' the first to supply the second, and the third to receive the product. A glance through this building enables us

to observe that the pipes, of which a large quantity is visible, are painted of different colours: this illustrates another of the peculiar rules whereby the operations of a distillery are governed; for in order to facilitate the supervision of the officer, and to enable him to trace the routine of processes conveniently, the legislature requires that every pipe for the conveyance of water shall be painted *black*, those for the conveyance of 'wort' or 'wash' *red*, those for the product of the first distillation *blue*, and those for the finished spirit *white*. Another regulation is, that whatever may be the size and arrangement of the distillery, ladders and all other conveniencies shall be provided for the easy access of the officer to all the different vessels.

The 'wash-charger,' into which the wash is conveyed from the fermenting-vessels, is a large iron tank or closed cistern capable of containing about thirty thousand gallons. By the express terms of the law, this vessel must be entirely closed in, and must communicate only with the fermenting-vessel and with the still, so that nothing can flow into it except from the former, and nothing flow out of it except into the latter. In the top or cover is a small hole, about an inch square, into which the officer dips a graduated rod; the object being to determine whether the quantity entering this vessel is the same as had been contained in the fermenting-backs. The officer keeps the key of the cocks or valves leading into and from this vessel, whereby nothing can enter the still until he has unlocked the requisite pipes. The annexed cut represents one of

[Wash-still.]

the two large wash-stills into which the wash flows from the wash-charger. This is a copper vessel capable of containing more than twenty thousand gallons. It is heated by a fire beneath, and is terminated at the top by a cover, which gradually decreases in diameter, and at length joins the 'worm,' of which we shall presently speak. The still is formed of plates of copper firmly riveted, and otherwise so contrived as to be air and water tight.

We must now consider briefly the nature of the process carried on in the large still. The 'wash' conveyed into it consists mainly of alcohol and water, in the proportion (generally) of about six gallons of pure alcohol, or twelve gallons of 'proof spirit,' in a hundred gallons of wash; 'proof spirit' being composed of about equal parts of alcohol and water. Water passes off in the form of vapour at a temperature of 212°; while alcohol does the same at the low temperature of about 180°; and the distiller avails himself of this circumstance to effect a separation of the two liquids. He applies fire to the still, by which the 'wash' is gradually heated; and when the temperature attains 180°, the alcohol begins to vaporise and to ascend to the top of the still. The heat is kept up to some point between the two extremes of 180° and 212°, until all the alcohol has passed off in the state of vapour. But during this process, partly on account of the restrictions imposed by the legislature, and partly through the scientific difficulties of the subject, a considerable quantity of water passes off with the spirit and mingles with it in the form of vapour. In France, where the operations of a distillery are not so rigidly controlled by the government as in England, improvements in great number have been from time to time introduced, with a view of effecting a complete separation of the two liquids in one operation: to what extent and under what limitations these attempts have succeeded, we need not discuss here; it will suffice to state that in England so much aqueous vapour passes over with the alcohol, as to render this latter comparatively weak. When all the alcoholic ingredient is distilled from the wash, the latter, under the name of 'spent wash,' is conveyed from the still to a large open vessel in the yard of the distillery. It is thence carried away in barrels by persons who keep cattle or pigs: the dry food of these animals, being sprinkled with some of the spent wash, acquires a fattening quality, which gives a value to the liquid after it has ceased to possess any to the distiller.

But it may now be asked, what becomes of the alcoholic vapour driven off by the heat of the still? The answer to this question forms the next step in our routine of processes. In the frontispiece is seen a very large cylindrical vessel near the chimney. This is called the 'worm-tub,' and contains the means for condensing the vapour after it has ascended from the still. This large vessel, which is between thirty and forty feet in height, contains a worm, or coil of copper-pipe, circling round it in a screw-like form from top to bottom. This pipe is not much less than two feet diameter where it enters the worm-tub, but gradually diminishes as it descends, till it leaves the vessel with a diameter of less than two inches. The vacant space of the worm-tub, not occupied by the pipe, is filled up with water, which is constantly flowing in from a water-tank, or 'liquor-back,' at the top of the still-house, an overflow from the top being necessarily provided for. All the vapour which ascends from the still passes into and through this worm or coil of pipe, and in its passage becomes condensed into a liquid by the coldness of the water contained in the worm-tub. Whenever vapour is condensed into liquid, a large amount of latent heat is given out; and as this occurs during the condensation of the vapour in the worm, the water in the worm-tub becomes gradually heated, until at length its temperature would be such as to unfit it for the office of a refrigerator, were there not a constant supply of cold water flowing in, and an equal quantity of heated water flowing out. The rate of change is so regulated as to keep the water in the worm-tub at as low a temperature as possible. There is another arrangement of worm connected with one or two of the stills, although the principle is the same. We pass up through the still-house to the roof, and there find that a large area is occupied by tanks or square cisterns, through which cold water is constantly flowing from the reservoir. The pipe forming the worm coils round and round in these tanks, gradually parting with its heat to the

water by which it is surrounded, and thus condenses the spirituous vapour passing through the worm from the still. By an ingenious arrangement the water, when too hot for the purpose of condensation, is allowed to fall on the float-boards of a large water-wheel, which thus furnishes moving-power for some of the pumps in the still-house.

The liquid which flows out at the lower end of the worm is called, in the language of the distillery, 'low-wines:' it is a very weak kind of spirit, containing all the alcohol previously existing in the 'wash,' mingled with a considerable quantity of water. As we shall now have to speak of the *strength* of spirit, it may be desirable to explain the nature of the standard employed by the Excise. Alcohol being of a lower specific gravity than water, a quart or any other quantity of the former would weigh less than an equal quantity of the latter; and any mixture of the two will weigh more or less according as the water or the alcohol predominates. The excise adopts as a standard that particular mixture of alcohol and water whose weight bears to that of an equal bulk of distilled water at a medium temperature the ratio of twelve to thirteen: that is, supposing a given bulk of distilled water weighed thirteen ounces, then an equal bulk of standard spirit will weigh twelve ounces. This particular degree of alcoholic strength is called 'proof spirit,' and is the standard to which all other strengths are referred: it consists almost exactly of one-half pure alcohol and one-half water. The strengths of all mixtures of alcohol and water—called by the general name of *spirits*—are ascertained by means of their specific gravity, and this is determined by a hydrometer, of which that kind known as 'Sikes's Hydrometer' is used by the excise. This instrument is capable of weighing all liquids as light as the strongest spirits of wine, or as heavy as water, and consequently all mixtures of the two. The scale of the instrument is graduated, and these graduations are said to be 'above proof' or 'below proof,' according as they indicate a degree of strength above or below that of 'proof spirit:' '100° below proof' is equivalent to pure water, while '70° above proof' is about equivalent to the strongest spirit ever produced by distillation. When the strength exceeds '43° above proof,' the liquid is known by the name of *spirits of wine*, and constitutes the strongest form in which spirit is presented to us, except in the refined operations of the chemist's laboratory.

These explanations will enable us to allude to the strength of spirits in the language of the distillery. We may proceed to state, then, that the 'low-wines' leave the worm of the wash-still at a strength very many degrees 'below proof,' in consequence of the large quantity of water mingled with the alcohol. The blue pipe which emerges from the worm-tub, and which contains the 'low-wines,' terminates in the curious piece of apparatus represented in the following cut. This apparatus is called the 'worm-safe,' and is intended to afford the means of testing the clearness and strength of the liquid flowing through it. The liquid flows from the end of the pipe into a hollow glass globe receiver, and from thence flows back through a larger pipe concentric with the former. By turning a small handle, a small portion of the liquid is made to pass into an upright cylindrical glass vessel two or three inches in diameter; and into this cylinder the hydrometer is introduced for measuring the strength of the liquid.

From the worm-safe the low-wines flow into vessels called 'low-wine receivers,' the stronger portion being allowed to flow into one receiver, and the weaker into another. These receivers, like all the other vessels employed in a distillery, are under the control of the

[Pipes at the Worm-end.]

excise-officer, who ascertains the quantity and the strength of the low-wines obtained by distillation. From the quantity and the specific gravity can be ascertained the amount of 'proof spirit' contained in the low-wines receiver, and this amount is entered as a check against the operations in other parts of the process.

The 'low-wines,' being much too weak for any of the ordinary purposes of spirit, have to be redistilled, as a means of driving off a considerable proportion of water. This redistillation is effected in other vessels called 'low-wine stills,' or sometimes 'spirit-stills.' But here some degree of complication occurs, of which we can only speak in a general way. Provided all the wash be distilled in the wash-still, and the product collected in the low-wines receivers, the excise allows the distiller a certain latitude as to the subsequent distillations in the spirit-still. He may redistil over and over again, with a view to improve the quality of his spirit, or to economize ingredients, provided the officer can retain throughout the means of determining that all the spirit obtainable from the wash is ultimately collected in the spirits-receiver; and that none is so collected but what can be thus accounted for. This latitude seems to have been allowed to the distiller partly because a portion of the spirit, redistilled from the low-wines, possesses a disagreeable odour and flavour, which must by some means be removed, and which the distiller may devise the means for removing more effectually if allowed to exercise his judgment in the matter. These impure portions of the spirit, which are called 'feints,' and which derive their peculiar quality principally from a fœtid oil yielded by the husks of the grain, are collected in separate receivers, and are thence reconveyed to the spirit-still to be redistilled. At this point in the proceedings, therefore, each distiller is enabled to exercise his judgment, and apply the results of his experience in the management of his distillery: hence, too, arise the distinctions between strong and weak 'low-wines,' and strong and weak 'feints,' distinctions made to further the views of the distiller. It will be sufficient for our present purpose, however, to state generally, that one distillation in the wash-still con-

verts all the alcoholic portion of the wash into low-wines; and that one distillation in the spirit-still converts the greater part of the low-wines into spirits, the remaining portion requiring a third distillation.

We had occasion to speak of two different modes of condensing the vapour adopted at the distillery, and have now to speak of a third. The spirit-still is surmounted by a tall copper cylinder, the interior of which contains a number of small pipes; cold water is kept constantly flowing through these pipes, so adjusted to the heat of the cylinder as to maintain a pretty constant temperature of 180° or 190°. Now as the vapour rises from the still into the cylindrical condenser, and comes in contact with the inner pipes, the aqueous portion falls down again into the still in the form of water, being unable to maintain the vaporic form when in contact with substances at so low a temperature as 190°. But the alcoholic portion remains in the state of vapour at that temperature, and passes off into the worm of the still, there to be condensed into spirit.

We have spoken only of one 'safe' for the exhibition and testing of the distilled product. But there are four such in the distillery to which our attention is directed: they are arranged two on either side of a convenient platform, raised a few steps above the floor of the still-room, and are adapted to receive the various kinds of 'low-wines,' 'feints,' and 'spirits,' as they proceed from the condensing-worms to the respective receivers.

The spirit-receiver is a vessel under the especial supervision of the excise officers, since the final adjustment of duty is regulated by the quantity and strength of the contents of this receiver. We have before stated that the officer gauges the quantity and specific gravity of the worts in the fermenting-back, and calculates the quantity of proof spirit which ought to be charged for therein, amounting to twelve gallons of proof-spirit from one hundred gallons of wort when the latter has a specific gravity of 1·060. He also gauges the quantity and strength of the proof-spirit in the 'low-wines,' in the feints, and lastly in the finished spirits, with a view to let one method act as a check to the other. The duty is paid on the actual quantity of proof-spirit in the spirit-receiver; but should this prove, on an average of a twelvemonth, to be less than the quantity estimated by the gauge of the worts or wash, the distiller has to pay up the deficiency: if, on the contrary, there is an excess, the excise retains the benefit of that excess. It was stated in evidence given before a Committee of the House of Commons on Distillation, a few years ago, that the quantity of proof-spirit produced is generally rather over than under the quantity estimated from the wash; but that the estimate is a very near approximation as a general average. If the spirit in the receiver is 'over-proof,' an increased rate of duty is not charged, but the spirit is hypothetically increased in quantity to the requisite dilution, and then the duty applied. Suppose, for example, there is one hundred gallons of spirit 25° over-proof; this implies that if twenty-five gallons of water were added the mixture would be at proof; the distiller is thereupon charged duty on one hundred and twenty-five gallons of proof-spirit.

From the spirit-receiver, the spirit passes to the store-warehouse, a long building situated in the western part of the distillery. Here are ranged seven or eight large store-vats, numbered (as most of the vessels are required by law to be in a distillery) and inscribed with their liquid capacity. This store-room is provided with the requisite conveniences for filling casks from the store-vats, and for despatching them from the distillery. As spirit does not, like beer, improve by being kept in store for a considerable period, there is no necessity for that vast array of vats which forms such an object of wonder at the great porter-breweries; and as spirit is, bulk for bulk, twelve or fifteen times dearer than porter, a small establishment of barrels, waggons, horses, &c. will be adequate for the business of a large distillery.

RECTIFYING AND COMPOUNDING.

Let us now recapitulate the steps through which we have traced the production of spirit. In the first place the grain—consisting of any of the usual varieties, and either raw or malted—is crushed or ground, as a means of allowing hot water to act more readily on the farinaceous ingredient. In the next place this grain is mashed with water till a heavy liquid called 'worts' is extracted. Then the 'worts' are fermented, by which the saccharine principle is converted into alcohol; and lastly, this alcohol is, by repeated distillations, separated from the greater portion of the water with which it had been combined. The result is called 'plain British spirits.' But we have not yet done with it; we have yet to trace it through the hands of another manufacturer.

The liquid so highly valued in science as 'spirit of wine,' the various forms of spirituous liquors known as hollands, whiskey, gin, British brandy, &c., and the cordials known as peppermint, cloves, aniseed, &c., are produced by the *rectifier* from plain spirit purchased by him from the *distiller*. This is a distinction which we have not hitherto had an opportunity of explaining. As a means of preventing any surreptitious proceedings in respect of duty, the excise laws prohibit the carrying on of two distilleries, or one distillery and a rectifying establishment, within a quarter of a mile of each other. They also limit the quantity of spirit which the distiller may sell, to a minimum of eighty gallons at one time, with which must be given a 'permit.' As a general rule we may state that British spirit (we exclude mention of Scotch and Irish whiskey, as, although plain malt-spirit, they are regulated by clauses in the act applying specially to them) is but little known in the form in which it leaves the distillery, since it receives from the hands of the *rectifier* the peculiar properties by which it is rendered familiar. The person's name often attached to spirituous, liquors, as a guarantee for the quality, is the name not of the distiller, but of the rectifier. There are only six distilleries in the vicinity of London, and, we believe, no more than nine in the whole of England, all the other establishments called by that name being places where the spirit, made from the malt or grain by the distiller, is redistilled, 'rectified,' or purified, and compounded with various vegetable substances to impart flavour.

Among the rectifying distilleries in the metropolis we have availed ourselves of permission to visit that of Messrs. Stephen Child and Son, in Trinity Street, Southwark, one of the most elegant and scientific manufactories we have ever seen, in which the resources of modern science are brought to bear on the particular branch of manufacture with much tact and discrimination. This distillery has been recently erected on a plot of ground belonging, we believe, to the Trinity House; and in virtue of a stipulation that the building should be an architectural ornament to the spot, the exterior has been made one of the most highly decorated in that part of the metropolis: indeed its façade would bear comparison with most of the West-end club-houses.

This distillery consists of a square court-yard surrounded by buildings. The eastern, western, and southern sides comprise various offices and buildings of a subsidiary character, such as warehouses, waggon-sheds, stables, harness-rooms, &c.; while the

northern side comprises the building in which all the operations of the distillery are carried on. This latter is surmounted by an ornamental chimney, which is likely long to retain its cleanly appearance, for nearly all the smoke produced by the furnaces is consumed; a principle the further adoption of which in our manufactories would be a step of incalculable benefit. We shall best describe the arrangement of the various parts of the building by tracing the progress of the spirit through them.

The raw spirit is sold by the distiller to the rectifier in two different strengths, viz. 25° over-proof, and 11° over-proof, both of which are rigorously fixed by the legislature. The spirit is brought to the rectifier in casks belonging to the distiller, with an excise permit; and an officer visits the rectifying distillery to see that all the spirits received there have paid duty: beyond this point the excise laws do not control the rectifier, except in one or two minor points. Supposing a cask of raw spirits to be conveyed to Messrs. Child's establishment, it is hoisted into a large square room called the warehouse, lined on two sides with rows of store-vats, and opening into the still-room. The cask is rolled upon a weighing-machine, which is connected to a very ingeniously constructed steelyard, whereby the weight of the spirit and cask is determined. The empty cask being afterwards weighed, affords the means of determining the exact weight of the spirit; after which a reference to a thermometer and to a printed table shows the exact number of gallons of spirit. The weighing-machine being level with, and indeed forming part of the floor, and the steelyard being portable, the necessity for heavy scales is wholly obviated.

When the full cask has been weighed, it is rolled over an opened trap-door in the floor, the bung is removed, an air-vent is opened, and the spirit flows out into a store-vat placed in the room beneath for its reception. This trap-door is provided with means for saving any alcoholic vapour which may rise from the spirit beneath. We next proceed to the underground vaults, where we see a range of store-vats for the reception of raw spirit, preparatory to the rectifying processes; and from thence we trace the spirit, by means of pipes, to the still-room, an apartment small in dimensions, but full of scientific appliances. On one side of this room we see a large iron tank, about thirty feet long and ten high: this is divided into four compartments, and serves as a worm-tank for containing the cold water with which the spirit is condensed. Immediately in front of this is a range of four stills, one for gin, one for spirit of wine, one for British brandy and British rum, and one for cordials. These stills are not heated by open fires, but by steam; a layer or thin stratum of steam being allowed to act on the lower half of each still, something on the principle of a sugar-boiler. The steam for this purpose is generated in two large cylindrical boilers, heated by smoke-consuming furnaces in which Merthyr Tydvil coals are burned, the steam-pipes being covered with non-conducting substances to prevent the loss of heat.

Supposing the spirit is to be converted into gin, one of the stills is seven-tenths filled from the store-vats, and steam is admitted to act on the still. The contents ascend in vapour, which is afterwards condensed in the worm-tanks. This distillation is the *rectifying* of the spirit, by which a certain portion of essential oil is removed from it. Then ensues the *compounding*, which is a redistillation with certain herbs, berries, and seeds, in order to impart the particular flavour whereby the liquid is known. Whatever may be the strength of the spirit when it comes into the hands of the rectifier, he reduces it, when in the form of gin, to a strength not greater than 17° under-proof.

If spirit of wine is to be made, the crude spirit is pumped into a still whose upper part consists of a vertical cylinder, containing a large number of pipes. The vapour ascending these pipes, and the pipes being surrounded by water at about 180°, the arrangement effects (on the principle we have before explained) so extensive a separation between the alcoholic and aqueous vapour, that spirit can be obtained as high as 62° over-proof. It must, by law, be as strong as 43° over-proof; but the saleable strengths are from about 54° to 60°.

If British brandy, British rum, or cordials are to be made, the spirit is redistilled with various vegetable substances calculated to impart the requisite flavour. By an ingenious arrangement, patented, we believe, by Messrs. Pontifex, the alcoholic vapour, instead of condensing in the worm-tank, passes into a flavouring-vessel containing the ingredients, so as to imbibe the qualities of those ingredients while condensing: it is again converted into vapour, and then passes through the worm-tank, to be finally condensed in the usual way.

All the various liqueurs, as condensed in the worm, are conducted by pipes into store-vats contained in a different part of the building; but in their way thither they pass through hollow vessels called 'safes,' similar in object and in principle to those employed at Messrs. Smith's, but differing in construction. In the still-room is also kept a powerful hydraulic press, capable of exerting a pressure of a hundred and fifty tons: this is employed for pressing some of the fruits used in the preparation of cordials, such as raspberry and cherry-brandy. In the upper part of the building is a store-room for the cinnamon, peppermint, cloves, aniseed, juniper-berries, and various berries, seeds, and fruits used in the preparation of cordials, and in flavouring the various kinds of spirit, together with the requisite apparatus for preparing them for the still.

In every part of this establishment the arrangements for the economising of heat are very complete. We have said that the furnaces consume nearly all their own smoke. This is effected by supplying fuel in su a manner, that the smoke from the new coal must pass over highly heated fuel before it can reach the chimney, whereby nearly all the carbon is brought into profitable employment. The stills, too, are not only heated by steam, brought from boilers in pipes covered with non-conducting substances, but the heat of this steam when condensed is even saved. A small apparatus called a 'condensing-box,' contrived by Messrs. Pontifex, is placed in the still-room for this purpose, and acts as follows:—As fast as the steam, admitted into a hollow jacket round the bottom of each still, becomes condensed into water by the lower temperature of surrounding bodies, this hot water flows into a cylindrical cavity in which a heavy circular stone moves up and down. This stone is exactly balanced by a weight at the other end of a lever, so that a small power suffices to move the stone. The hot water, filling the space beneath the stone, gradually raises it, and in so doing acts upon a catch which opens a valve, and allows all the water to descend into the boiler in the room beneath. Thus all the heat contained in the condensed steam is effectually preserved.

The boilers, steam-engines, and pumps, employed in the various operations of the establishment, are all of the most modern forms, and are arranged with singular economy of space, each being placed within a very few feet of the spot where its power is to be practically applied.

We have, in conclusion, to acknowledge the courtesy of the respective proprietors of these two establishments, in affording the means for presenting this brief outline of a manufacture in which so large an amount of scientific skill is involved.